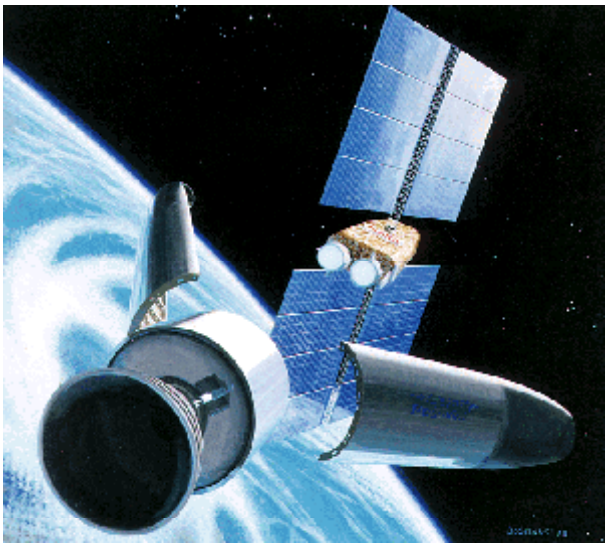
TEMPEST: Twin Electric Magnetospheric Probes Exploring on Spiral Trajectories--A Proposal to the Medium Class Explorer Program



Artist's concept of TEMPEST vehicle.

The NASA Lewis Research Center participated as a member of the Twin Electric Magnetospheric Probes Exploring on Spiral Trajectories (TEMPEST) Middle Class Explorer proposal team. This team was composed of Lewis, TRW, the University of California at Los Angeles (UCLA), SwRI, the Aerospace Corporation, the University of Iowa, the University of Maryland, the University of California at Berkeley, the Max Planck Institute, and Rice University. Lewis provided technical information, mission analysis, instrument description and requirements for one scientific experiment, and proposal logistics and publication for the TEMPEST proposal.

The objective of the TEMPEST mission is to understand the nature and causes of magnetic storm conditions in the magnetosphere whether they be manifested classically in the buildup of the ring current, or (as recently discovered) by storms of relativistic electrons that cause the deep dielectric charging responsible for disabling satellites in synchronous orbit, or by the release of energy into the auroral ionosphere and the plasma sheet during substorms.

This mission will be accomplished by two low-mass spacecraft launched by Pegasus rockets into orthogonal 400-km-altitude orbits (high and low inclination) carrying a small complement of instruments to detect, measure, and characterize basic particles and fields. Xenon-ion engines, developed at Lewis and powered by solar arrays, will take these spacecraft on a spiral trajectory from 400 km completely through the magnetosphere to 15 Earth radii, circular, in 2 years.

One of the science packages is a derivation of Lewis' Solar Array Module Plasma Interaction Experiment (SAMPIE) that was flown on space shuttle flight STS-62. This Spacecraft Interactions Package (SIP) will determine how the spacecraft interacts electrically with its environment. Interactions of interest include spacecraft charging in auroral and geosynchronous plasmas and parasitic current collection from the denser plasmas at low altitude.

The spacecraft xenon ion engines and power-processing units are being developed jointly at Lewis and the Jet Propulsion Laboratory through the NASA Solar Electric Propulsion Technology Assessment Readiness (NSTAR) program. The ion engines' 3300-sec average specific impulse is a key enabler of this mission, allowing a slow spiral through all of the magnetospheric regions of interest. Also key to this mission's success is the capability of the ion engines to throttle over a range of approximately 0.5- to 2.5-kWe input power.

Lewis is providing mission design and analysis for TEMPEST. Lewis' Advanced Space Analysis Office designed and will continue to refine the TEMPEST spacecraft trajectories, including launch window determination, coast phases, inclination changes, and input to the spacecraft guidance, navigation, and control algorithms.

This mission proposal is being evaluated by NASA Headquarters' Office of Space Science. Should this program be selected, it could be the first application of xenon-ion solar electric propulsion to a NASA space science mission.

Bibliography

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